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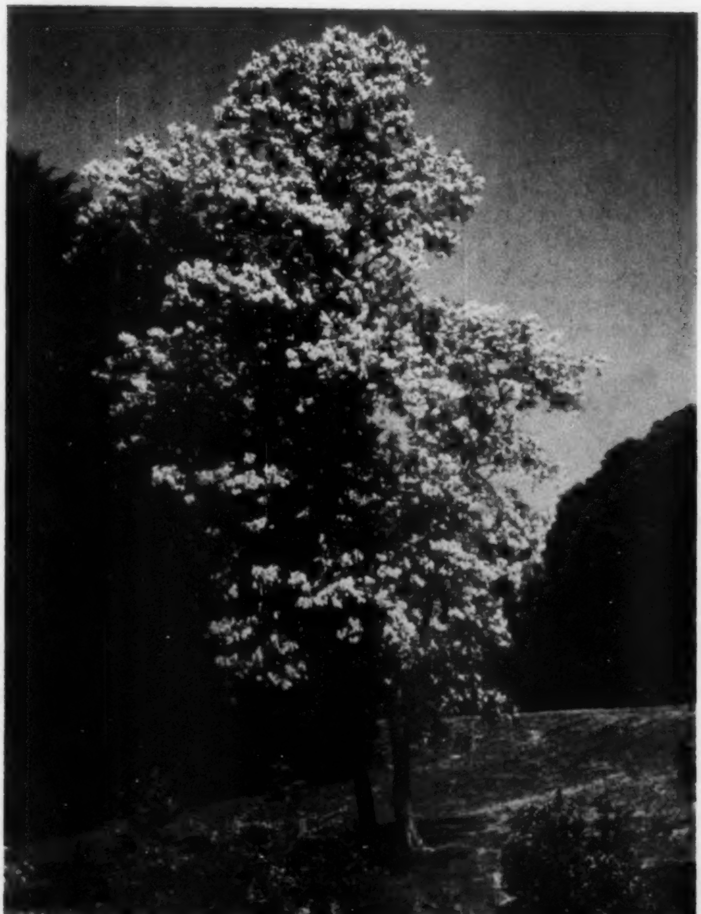

Robinia pseudoacacia

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Sustaining	$10.00 a year	Sponsoring	$100.00 a year
Donor	$500.00		

Arboretum Activities

The Staff

From October 7 to 10 the Director participated in the Annual meetings of the American Horticultural Council and the American Association of Botanical Gardens and Arboretums which were held at Rochester, New York. On November 6 he attended the semi-annual session of the Visiting Committees for the Arnold Arboretum at Jamaica Plain, Mass.

October 26 was the official date of publication of a new book by Dr. H. L. Li entitled "The Garden Flowers of China." This volume is reviewed elsewhere in these pages. A revised and enlarged edition of Dr. Li's "Chinese Flower Arrangement" was published by D. Van Nostrand Company on November 20.

Miss Mary Milton and Mr. Fairman Jayne represented the Arboretum at the meetings on the American Holly Society which took place at Easton, Md., on October 31.

Floriade

One of the important topics discussed at the A.A.B.G.A. meeting in Rochester on October 10 was the participation by the member institutions in the forthcoming international horticultural

(Continued on Page 67)

The Black Locust and Honey Locust[1]

Hui-Lin Li

The early American colonists, like all other immigrating people, were at first more interested in trees of their original homes than in the native plants of their adopted land. Since the very beginning efforts were made to introduce nearly all important cultivated species of European trees into America, in spite of the fact that practically all of these have their counterparts in eastern North America. Moreover species of the same genera that are indigenous are more suitable to the local climate. The American flora is actually far richer than that of Europe. Not only are more genera represented, but there are usually more species in the same genus in America than in Europe.

Only a few of the native American trees were thus cultivated during early colonial times, while most others were not introduced into cultivation until the eighteenth or nineteenth centuries. The cultivation of native trees gained great momentum toward the end of the last century as a result of wider interest in gardening, conservation, and tree culture as well as the establishment of numerous arboretums and botanical gardens throughout the country. Since then nearly every important native species of trees has been in cultivation one way or another.

The trees of American origin therefore have a much shorter history of cultivation than most other important trees from Europe and Asia. Within the short span of about three hundred years, however, two outstanding species have already gained world-wide recognition, and are sometimes more extensively cultivated and better known in some other parts of the world than in their native home. The two species, both plants of the Pea or Legume family, are the Black Locust and the Honey Locust.

The Pea Family

The Pea family, Leguminosae, is one of the largest families of flowering plants. The very numerous genera and species, estimated at over 500 and 8,000 respectively, are widely distributed all over the world and are most abundant in the tropics.

As food plants the many edible legumes are second only to cereals in importance. Because of the fact that they are very rich in proteins, their use supplements the high carbohydrate contents of cereals. In many parts of the world peas and beans actually take the place, in part or nearly in whole, of foods derived from animals.

The Leguminosae have a unique susceptibility to certain root-inhabiting, nodule-forming bacteria that synthesize nitrates from free nitrogen. This process is an extremely important one, because atmospheric nitrogen cannot be used by higher plants in the lengthy process leading to protein formation.

Part of the nitrates formed by the bacteria can be utilized by the leguminous host plants, and part eventually by subsequent crops. Thus, the high nitrogen content of legumes not only contributes to the food value of beans and peas, but also makes these plants useful as fodder and for enriching the soil. The importance of legumes to human economy and agriculture is indeed very great.

The Black Locust

The Black Locust, *Robinia pseudoacacia,* is one of about 20 species of a genus which in North America is distributed from Pennsylvania south to Mexico. Some of the species are of tree size while others remain as shrubs. The Black Locust is the most wide-spread and the most commonly planted species. It is also known as Locust, Common Locust, Yellow Locust, White Locust, and Acacia. The name Locust was given by early missionaries who fancied that the tree was the one that supported St. John in the Wilderness (Loudon 1838). It is, of course, an American tree which is not native to any other part of the world. The true locust of the New Testament is most probably the Carob, *Ceratonia siliqua.*

The Black Locust is a medium-sized tree, usually attaining a height of about 45 feet, but may reach as much as 75 feet. The reddish dark brown bark, deeply furrowed and ridged, is quite distinct in appearance. The branches and branchlets bear sharp spines at the nodes, usually in pairs. The feathery odd-pinnately compound leaves, dark green in color, and the large drooping clusters of very fragrant white flowers together make the tree a highly ornamental one. (Fig. 41).

[1]Fig. 42, courtesy of Edward H. Scanlon, Trees Magazine. Figs. 43-45, courtesy of Vogin Vasilic, Director, Zavod za Kulturu topola, Novi Sad, Yugoslavia; received through Dr. E. J. Schreiner.

Fig. 41. Black Locust, *Robinia pseudoacacia.*

As noted above, the Black Locust has the widest range of all species in the genus. The original habitat extended from the mountains of Pennsylvania to Georgia and westward to Iowa and Kansas and Oklahoma, but it is now widely naturalized in many other parts of North America. Several insects, the Locust borer and Locust leaf miner, and the fungal Locust rot are doing considerable damage to the trees locally. The tree occurs in a wide variety of conditions. On moist fertile soil, along streams or on rich bottomlands, it grows especially vigorously but it also thrives on rocky sterile slopes.

Uses of the Black Locust

The wood of the Black Locust is of excellent quality, especially in straight and clean forest-grown specimens free from insects or other enemies. It is very hard and strong, yellowish brown to reddish brown, with thin greenish or yellowish sapwood. It is very durable in contact with soil. In former times it was used extensively for ship-building. It is now used for posts, poles, or ties, for tree nails, insulators, pins and fuel.

The Black Locust, like many other legumes, has nodules on the roots. It can be used as a soil improver for pastures or bare lands. The leaves may be used as fodder. The tree is also an important honey plant.

The use of Black Locust in former times as tree-nails in the construction of wooden ships is of particular interest. These nails, the thick long wooden pins holding together timbers, were subject to great stresses. In colonial times, the Black Locust nails were used with great success, owing to their great strength together with amazing decay resistance. By 1820 Philadelphia alone exported between 50,000-100,000 locust nails to England annually. A member of Parliament rose to point out that unless the British Navy adopted Black Locust tree-nails it could not hope to equal the American ships (Schramm 1942).

Introduction of the Black Locust into Cultivation

The Black Locust is perhaps one of the very few trees planted by Indians in the temperate regions of North America before the arrival of the colonists. It appears to have been common in the neighborhood of the coast when Virginia was first settled by Europeans (Sargent 1892). William Strachey, who first visited the colony on James River in 1610, mentioned this tree in his *Historie of Travaile into Virginia Britannia.* He found that "by the dwelling of the salvages are bay-trees, wild roses and a kynd of low tree, which beares a cod like to the peas, but nothing so big: we take yt to be locust."

The Indians made their bows from the wood of the Locust. According to Sargent (1892), it is quite probable that the Indians of Virginia carried the tree from the mountains to the low country and so helped the tree to spread beyond the limits of its original natural forests along the slopes of the Appalachian Mountains.

The exact date of its introduction into Europe cannot be ascertained. Some authors, such as Linnaeus and Miller, claim it was 1601 when the botanist Jean Robin after whom the genus was named, is said to have obtained seeds from America; others such as Adanson and Deleuze maintain that it was not until 1636 when it was planted in Paris by Vespasien Robin. son of Jean Robin. This particular tree, the oldest known of its kind in Europe, is still living in the gardens of the Museum d'Historie Naturelle. (Fig. 42). The English, however, might have introduced the tree into England at an earlier date as John Parkinson, who published the first description of the tree in 1640 in his *Theatrum Botanicum,* observed that the Locust had been raised near London by Tradescant to already "an exceeding height." (Elwes & Henry 1912).

In the seventeeth and early eighteenth centuries, the Locust had attracted great public attention in Europe and numerous papers had been published on its horticultural value. (Elwes & Henry 1912). In 1892 Sargent was to write that, "No other North American tree has been so generally planted for timber and ornament in the United States and in Europe; and no inhabitant of the American forest has been the subject of so voluminous a literature."

The tree has since been planted in nearly all countries in Europe, and in South Africa, North Africa, South America, Asia, Australia and New Zealand (Spaulding 1950). In many countries the Black Locust is the most extensively used tree for reforestation. (Blümke 1956).

The Shipmast Locust

A number of geographical strains or races of the Black Locust have been reported but most of these are probably differences resulting from environment. Among these, the most outstanding and distinct is the variety 'Rectissima', the Shipmast Locust, described from Long Island by Raber in 1936 but introduced there apparently over two centuries ago possibly from tidewater Virginia. The lasting quality of the wood of this tree is probably unsurpassed by any other in the eastern United States. Fence posts over one hundred years old have been resold for further use. This is a wood that can be adapted to many special uses. The Morris Arboretum made use of the timber in constructing greenhouse benches in 1942 (Schramm 1942) and in building a lath house in 1949 (Skinner 1949). The latter structure is in good condition after ten years.

Fig. 42. The Robin Black Locust in Paris.

Variations of the Black Locust in Cultivation

A large number of varieties of the Black Locust have arisen in cultivation (Sargent 1892, Rehder 1940). The more important and distinct ones are here enumerated. Nearly all of these originated in European, especially French gardens in the nineteenth century. They are mostly propagated by grafting.

1. 'Crispa' — An unarmed form with undulate or crinkled leaf margins; originated before 1825.
2. 'Decaisneana' — A vigorous tree with light rose colored flowers; originated before 1860.
3. 'Dissecta' — A compact tree with short branches and dissected leaves; originated before 1869.
4. 'Inermis' — Unarmed; originated before 1904. This is the form usually planted in Europe for fodder.
5. 'Latisiliqua' — Pods broad; originated before 1829.
6. 'Macrophylla' — Leaves long and leaflets broad; originated before 1830.
7. 'Microphylla' — Leaflets small and narrow; originated before 1830.
8. 'Pendula' — With somewhat pendulous branches; originated before 1820.
9. 'Pyramidalis' — A form with unarmed erect branches forming a narrow pyramidal head; originated in 1839.
10. 'Tortuosa' — a distinct form with short twisted branches, short in stature and slow in growth and usually few-flowered; originated before 1810.
11. 'Umbraculifera', Parasol Acacia. — An unarmed form with short branches forming a dense spherical head; originated before 1810. This is the form much used in Europe by grafting high for formal planting. It is also

Fig. 43. Parasol Acacia, Novi Sad, Yugoslavia — old trees.

one of the most popular street trees in central and northern Europe. It rarely produces flowers. (Figs. 43-45).

12. 'Unifolia' = 'Monophylla' — A form with the leaves sometimes reduced to one large leaflet or more often with 2-3 leaflets or more; originated in 1855. (Figs. 46 & 47).

Other species of Robinia

With the exception of the Black Locust, the other species of the genus *Robinia* are mostly shrubs or, at most, small trees. They are cultivated only occasionally, and generally used locally as ornamentals for their showy and often fragrant flowers. The most commonly planted one is the Clammy Locust, *Robinia viscosa,* a small tree which grows to a height of about 35 feet. The tree can be readily distinguished from the Black Locust by its stiff glandular viscid reddish brown hairs densely covering the young branches. The leaflets are more numerous (13-25) than in the Black Locust (7-19). The tree is native to southeastern United States and has been cultivated since the late eighteenth century.

Among the shrubby species, the more commonly planted are *Robinia hispida* and *R. fertilis,* both natives of southeastern United States. These species grow to a height of only 3-6 feet and are planted mainly for their showy rose-colored flowers.

The Honey Locust

The Honey Locust, *Gleditsia triacanthos,* is a native of the eastern part of North America, extending from Ontario through Pennsylvania to Florida, westward to Kansas and Texas. It is now widely planted and in many places it has escaped cultivation and become naturalized. In some parts of the country it is also called Sweet Locust, Three-horned Acacia, Thorn Tree, Honey Shuck, or Black Locust.

The tree is of medium size attaining usually a height of about 50-100 feet, but sometimes it may grow to a height of nearly 150 feet. The trunk is usually short, branching low, but in close stands it may be rather long and clean. The bark is grayish brown to almost black, usually rough with a few fissures and thick, firm broad ridges. It is often covered with stout, simple or 3-branched thorns which are frequently also found on the twigs. The long even-pinnately once- or sometimes twice-compound leaves are quite ornamental. The greenish flowers, in male and female clusters, are very fragrant. The distinct large leathery fruit pods measure one to one and a half feet long. (Fig. 48).

The Honey Locust is a rapidly growing tree. In its original habitat, it develops best in rich soil along moist bottomlands, but it will grow in any fertile soil which is not too wet. It is a light-demanding tree.

Uses of the Honey Locust

The wood of forest-grown trees of the Honey Locust is of excellent quality, but in open-grown trees, it usually becomes too knotty. The wood is hard, coarse-grained, strong, heavy and durable in contact with the soil. It is bright reddish-brown in color with thin pale sapwood. It is used mainly for fence posts, poles, ties, fuel and lumber for general construction.

The Honey Locust is a highly ornamental tree but as a shade tree it is not satisfactory on account of its late leafing in the spring. The tree is an important honey plant. According to Smith (1950), it lacks the root nodules common to most legumes. The pods are edible and can be used as a valuable stock food.

Other species of Gleditsia

The genus *Gleditsia* is composed of about twelve species, distributed in North and South

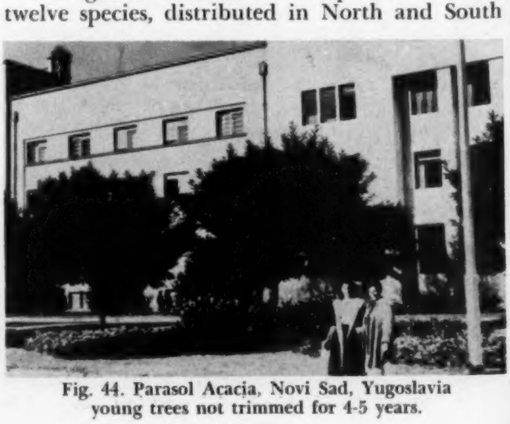

Fig. 44. Parasol Acacia, Novi Sad, Yugoslavia
young trees not trimmed for 4-5 years.

Fig. 45. Parasol Acacia, Novi Sad, Yugoslavia — trimmed young trees.

America, and in the Old World in Central and Western Asia and in tropical Africa. Besides the Honey Locust, there are two other species in North America. The Water Locust, *G. aquatica,* inhabits river swamps of southeastern and southern United States. The Texas Honey Locust, *G. texana,* occurring in the U.S.A. from Mississippi to eastern Texas, is believed by Sargent (1902) and Elwes & Henry (1912) to be a putative hybrid between the Honey Locust and the Water Locust.

A number of species from eastern Asia are now in general cultivation. The most important cultivated species there is *G. sinensis,* a medium-sized tree quite similar to the American Black Locust in general appearance. This is the famous "Soap-pod Tree" in China, where the pods have been used since ancient times as soap by boiling in water and producing lather. This is used especially for cleaning furniture as it will not damage any wood structure.

Introduction of the Honey Locust into Cultivation

The Honey Locust was cultivated early by American colonists sometime in the late 17th century. The first account of it, drawn from the cultivated tree, was published by Plukenet in 1700 in his *Amalthum Botanicum,* with a brief description and illustration.

The tree was first cultivated in Europe by Bishop Compton in his garden at Fulham near London in about 1700 (Aiton 1789, Loudon 1838). It was known in France in the early eighteenth century and spread shortly afterwards to other European countries.

Since its first introduction into cultivation, both in America and in Europe, the Honey Locust has been extensively planted. Its readiness to grow from seed, rapid growth, easy culture, extreme hardiness are among the commendable characters that make it popular for planting in gardens, parks or along highways. Its only drawbacks are its lateness in sending out leaves in the spring and a serious insect pest, the mimosa webworm in the Philadelphia area. An especially desirable character of the tree is its ready adaptibility to any soil conditions.

Fig. 47. *Robinia pseudoacacia* 'Unifolia' — variation in leaves.

Fig. 46. *Robinia pseudoacacia* 'Unifolia'.

The Honey Locust is cultivated in most countries as an ornamental tree. It has been reported to be useful as a fodder in Australia and other places. It is doing well in such wide-ranging areas as the steppes of southern Russia and Tunisia in Africa (Smith 1950), and is reported also in cultivation in South Africa and South America (Spaulding 1956).

Variations of the Honey Locust in Cultivation

Gledistia triacanthos is a more or less uniform tree with few variations. In its natural populations or in cultivation, there appear occasional individuals which are unarmed or nearly unarmed, and these trees are usually of slender habit. These plants are referred to as f. *inermis.* In cultivation, only a few variations have appeared as follows:

'Bojutii' = 'Pendula' — A tree with graceful pendulous branches and small narrow leaflets; originated before 1845 from cultivated plants in France.

'Elegantissima' — Of dense bushy habit, unarmed and with smaller leaflets; originated about 1880 in France.

'Nana' — A somewhat smaller more compact shrub or tree with shorter, broader, dark green leaflets; originated before 1838 in England.

Fig. 48. Honey Locust, *Gleditsia triacanthos.*

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New Associates

The Arboretum is happy to welcome the following new Associates who have been enrolled since September, 1959:

Bonsell & Troutman

Mr. Joseph P. Diviny

Edison High School

Mr. and Mrs. Edward Fischer

Mrs. E. Hendricks Funk, Jr.

Mr. Fairman R. Furness

Mr. and Mrs. C. C. Henley, Jr.

Mr. Francis J. Hoban

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Mrs. John K. Knorr, III

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Mrs. Allen J. Sprow

The Testing of Tree Seed in the Laboratory and in the Nursery

C. E. HEIT[1]

Tree seed testing for mechanical purity analysis and for percentage of germination has not been practiced in our country as widely as the testing of most agricultural seeds. There have been many reasons for this fact such as the lack of knowledge of the germinative characteristics of tree seed by the seed analysts. Also the nurseryman, forester and planter have thought that tree seed could not be tested in the laboratory. The volume of tree seed was relatively small compared with other seeds, and the demand for good germination and high quality tree seed has been lacking.

The writer has been closely associated with seed germination studies since 1928 both in the commercial and State nursery propagation field and recently in research work and seed testing at the N. Y. State Agricultural Experiment Station. He has observed many times the crop failures in nursery seedbeds which were due to poor, old, weak or actually dead seed. This seed was either collected or purchased by the nurseryman and was planted without definite knowledge of its germination value. Sometimes he had too much faith in the seed dealer who sold the seed to him thinking that the germination would result in a good field stand (see Fig. 55).

One progressive seedsman and nurseryman as early as 1887 clearly stated that tree seed needed a thorough system of seed testing and the adoption of the principle that all samples of seed should be tested by an authorized laboratory and that such seed should pass a specified test before being issued to planters. Within the past 10-15 years and particularly within the last 5 years nurserymen, tree seed collectors, dealers and private planters in our country have become more seed quality conscious. They are requesting germination tests on the seed which they collect, sell or plant. They are also demanding that seed analysts furnish them with this information in a reasonable length of time.

Since 1940 the writer has been studying the optimum conditions of light, temperature, moisture and substratum on the germination of tree seed with the idea of developing a standard method for testing each species which would give rapid and complete germination in the shortest time. Such factors as dormancy, seed source variation, abnormal germination and seed vigor were given careful attention.

Temperature and Light Factors in Germination

In the early years of the studies it was found that temperature and light were two very critical factors in securing optimum germination. The effect of light and temperature on dormancy in Scotch pine seed was reported in 1940 by Eliason and Heit (2). Recently the writer (6) published the findings of 18 years study on the germination of ten hard pine species. Suggested methods for testing these pines in the laboratory were given, all of which can be tested within 14-21 days. It was found that there was no need for long test durations with any of these pine species when optimum temperature (a 20-30°C alternating) and artificial light conditions were maintained during these tests. Copies of this article as well as the writer's other two articles cited under literature will be sent upon request. Both Figures 49 and 50 show clearly the stimulating effect of artificial light upon germination in the laboratory of Scotch and Austrian pine. It must be necessary to have temperature and moisture at the optimum also as any one factor may be a retarding influence on rapid and complete germination. Note the germination percentages of 92-98% in Figure 49 after 6 days yet under less optimum conditions these same lots germinated only 30 to 90% at the same time.

Light may have a stimulating effect upon germination at various temperatures (Fig 50) but some temperatures themselves will retard or prevent actual germination and then light ceases to function as a stimulating factor. Most coniferous trees did not respond well at temperatures

[1] Mr. Heit is Seed Technologist at the Department of Seed Investigations, New York State Agricultural Experiment Station, Geneva, New York. Besides research studies this Department maintains a seed testing service for individuals, seed dealers, and various agencies for labeling and planting purposes. It also tests seed for law enforcement purposes in cooperation with the N. Y. State Department of Agriculture and Markets.

Prior to 1940 Mr. Heit was connected with the New York State Conservation Department for 9 years in nursery production and investigation studies on seed testing and dormancy problems. For three years he was associated with one of the largest wholesale nurseries in the United States in their evergreen propagating department.

For the past 15 years he has operated a small personal experimental seedling and transplant evergreen nursery in which he specializes in seed source studies of pines, spruces and firs. Many exotic kinds of these three groups are being grown, tested and distributed to Christmas tree growers and nurserymen.

Fig. 49. Rapid, maximum germination of Scotch pine seed from 6 native Spanish sources after 6 days on top of blotter at 20-30°C alternating temperature in fluorescent light during the 8-hour high temperature period. Germination varied from 92-98%.

of 15°C or oftentimes 20°C. Most of the spruces, hard pines and some firs and cedars will germinate readily and completely at 20-30°C alternating temperature with the addition of artificial light within 10-30 days without any prior moist prechilling or stratification treatment. These findings are in disagreement with beliefs published years ago by Barton (1) and by recommendations as recently as May 1959 by Swofford (8), who still suggested pretreatment of 30-60 days at 3°C for several hard pines including *Pinus echinata, P. rigida, P. sylvestris* and *P. Taeda* before germination test.

Hardseededness and Embryo Dormancy

Some tree seed exhibited hard seed coats such as the locusts, redbud, sweetshrub, sumac and many others. These seed must be clipped, filed, scarified, or treated with sulphuric acid so as to allow water to penetrate the seed itself and embryo before germination will occur. The effect of concentrated sulphuric acid treatment on an extreme hardseeded lot of staghorn sumac is shown in Fig. 51. It actually required 6 hours treatment with this lot to secure prompt maximum germination of all viable seed. It will be interesting for the readers to note that this lot of sumac seed which showed no germination in the check or untreated seed in the photo is still in the germinator after 15 years. At present the check or untreated seed has germinated 2.5% and the one hour acid treatment lot has germinated 11%. These seeds have been under constant moist germinating conditions at room temperature and counts are recorded yearly or as necessary. One-half to one hour acid treatment is usually sufficient to secure germination with most hardseeded tree species.

Some tree seed exhibit extreme dormancy and will not respond to germination in the laboratory unless the seed is after-ripened at 3-5°C for 1-4 months. Most of the white pine group, hemlock, some firs, fruit seed, and many hardwood and shrub seed require this pretreatment before the seeds will actually produce normal germination. Once this moist prechilling and after-ripening treatment has taken place it has been generally assumed that the prechilled seed will germinate promptly at most any temperature. Our studies have found that even prechilled seed of some tree species are sensitive to temperature during germination. It was found that prechilled seed of certain species will not germinate satisfactorily if placed at too high temperatures (especially constant) for their germination test. Figure 52 shows the response of completely after-ripened apple seed when it was placed to germinate at temperatures of 15° and 25°C. At 15°C rapid, complete, uniform, germination of 98% was secured after 5 days while only 35% was secured at 25°C after 5 days, 42% after 10 days, and only 66% germination after 21 days. The seed will revert back into dormancy again when placed at these undesirable temperatures. Many temperatures were studied in similar tests but most consistent germination results were secured with prechilled apple and pear seed when it was germinated at temperatures about 15°C.

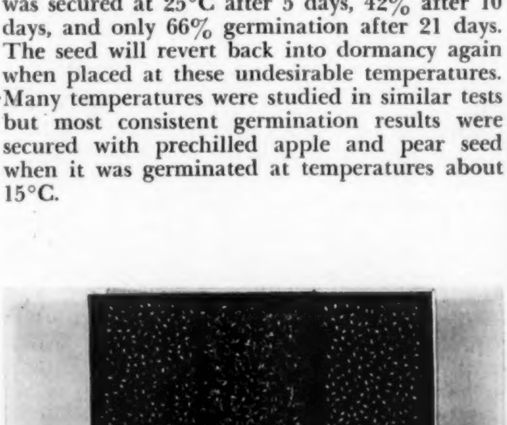

Fig. 50. Germination of two lots of Austrian pine at 20° and 25°C in closed, dark germinators; center lot in constant artificial fluorescent light with temperature varying from 21-25°C. Note 95-100% sprouting in artificial light after 5 days.

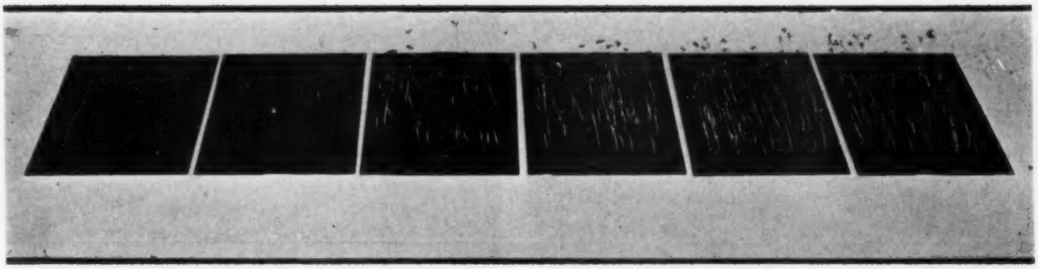

Fig. 51. The effect of concentrated sulphuric acid treatment on staghorn sumac (*Rhus typhina*) seed in laboratory testing after 10 days. From left to right, Check — no acid; 1, 2, 3, 4, and 6 hours — H_2SO_4 at room temperature respectively. Germination varied from 0% to 52% germination after 6 hours.

Laboratory Testing by Embryo Excision

The seed analyst must be able to test seed for germination in a reasonable length of time to be of any value to the seed dealer, buyer or planter. The embryo excision method for determining approximate viability in extreme dormant seed was first reported by two workers, Flemion (3) and Tukey (9). The writer has used this method for testing forest tree seed such as ash, certain pines and magnolia since late 1930 and in 1955 published a summary (5) of twenty years study on this method. A compilation of literature is given on this method including 29 references several by Flemion and numerous other research workers. A complete list of nearly 100 kinds of flowers, vegetables, shrubs, vines, and fruit, coniferous and broad-leaved trees is also given on which the writer has tested successfully by this embryo excision technique. Six figures are also shown depicting the embryo response of various types of seeds.

The embryos are removed from the seed after soaking the seed in water from 1-4 days. These embryos are placed in closed dishes on a moist substratum in light at temperatures preferably between 62°-72° F. Good, live seed will germinate, show some greening of the embryo or spreading of the cotyledons or remain firm and white. The weak or dead embryos will discolor, severely mold or decay. Details of this method of testing can be found in the published summary or the many references listed therein. Techniques of seed pretreatment and subsequent embryo removal vary with the kind and type of seed to be tested. Figure 53 shows the response of 4 peach stocks tested by the embryo excision method. Reliable results can be secured in 5-15 days by this method which might take 1-5 months by normal germination of after-ripened seed in these extreme dormant species.

Other Quick Tests

Many other so-called quick tests have been developed and tried on dormant tree seed during the years including chemical reactions, electrical response, specific gravity, catalytic activity, etc. The most recent and most widely publicized quick test is the tetrazolium chloride staining method. The writer has used this tetrazolium test on many kinds of tree seeds and found it to be unreliable especially with weak or old seed stocks. Flemion concluded, after comparing this staining test with the embryo excision test, that the results were too irregular to recommend it as a method for testing any given species.

The writer believes the tetrazolium chemical test serves a purpose and on certain extreme dormant species when the embryos cannot be excised it does give indication whether the seeds are live or dead and is more accurate than the old fashioned "cutting" or "hammer" test. As an emergency test it also has some value at times and as a supplementary test on certain seed lots it has been helpful.

Abnormal Germination, Weak Seed

The seed analyst must be constantly alert in testing seed so as to detect abnormal germination and weakened vitality in certain seed lots. Tree seeds quite frequently show abnormal germination. Mechanical injury during the extraction or cleaning of tree seed may cause abnormal germination. Poor storage conditions or aging of the seed is the most common cause of poor, weak, abnormal germination. Only those seeds which germinate and produce a normal, vigorous seedling should be counted as germination

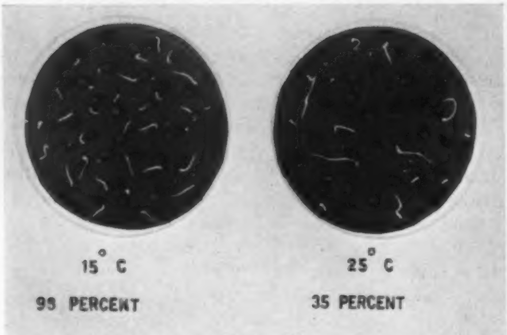

Fig. 52. Difference in germinative response of prechilled apple seed after 5 days at two constant temperatures of 15°C and 25°C. Note rapid, uniform germination when seed was placed at 15°C.

percent. Figure 54 shows normal and abnormal germination in Austrian and red pine. The radicle is the important structure of any tree seedling and unless the root tip is vigorous, active and healthy one must beware of trouble. Slow, weak abnormal root development during laboratory testing with profuse fungus growth on the seeds definitely indicates that the stock has weakened vitality with doubtful seeding value.

High Quality Tree Seed Possible

The quality of tree seed is dependent upon the proper use of methods of collection, extraction, cleaning and storage. With our modern machinery today, the mechanical purity of most tree seed should be 95-100% pure and nearly free of foreign material such as needles, leaves,

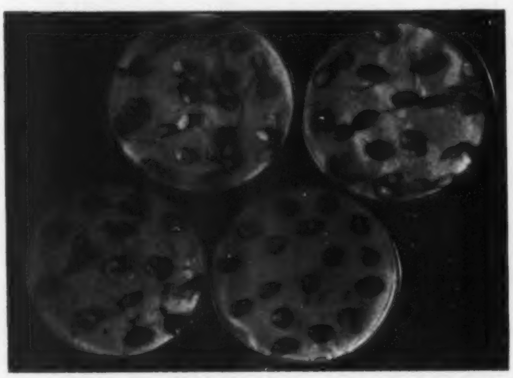

Fig. 53. Comparison of vigor and growth of 4 peach stocks tested by the embryo excision method. Upper left — strong seed, vigorous growth; Upper right — good reliable stock, fair vigor; Lower left — weak, old, moldy, doubtful planting value; Lower right — dead, no embryo activity. Actual germination of these stocks after being properly after-ripened were 80, 52, 18, and 0% respectively.

Fig. 54. Laboratory germination of Austrian pine (left) and red pine (right) showing normal, good germination with strong seedling development and weak, abnormal stunted germination which will not produce tees in field plantings. Note vigorous, healthy root on normal seedlings.

stems, dirt, stones, cone scales, wings and resin. Empty seed can be eliminated in all pines, spruces, hemlock and some firs. They can be greatly reduced in larches, cedars, and firs by proper screening and blowing. Mature seed freshly collected of pines, spruces, hemlock, and some other conifers should be 90-100% viable. Many commercial seed lots testing during the past few years at the Geneva laboratory have shown over 90% germination and over 98% mechanical purity. Unclean seed with excessive inert matter or empty seed should not be accepted by any nurserymen.

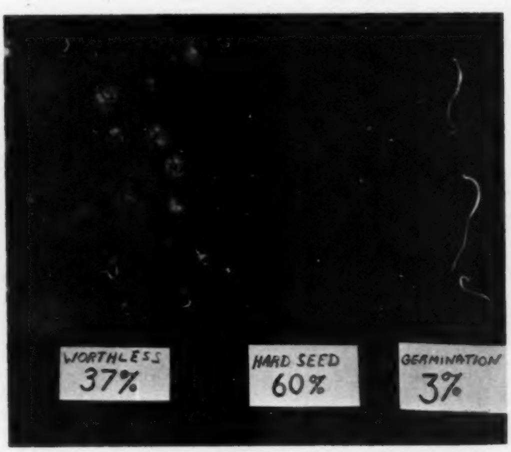

Fig. 55. Laboratory response of honey locust seed which had been purchased from a dealer, planted in the nursery with a stand failure. Note dead seed, only 3 weak sprouted seedlings. Most of the hard seed were found to be dead in test.

MAKE SEED DEALER RESPONSIBLE

Nurserymen, foresters, Christmas tree growers and private gardeners should make the dealer responsible for the quality of the seed which he sells. Many nurserymen have bought seed blindly in the past as was experienced by the company which planted the honey locust seed shown in Figure 55. After buying the seed, paying for it and then planting the seed without a germination test no field stand was secured. Our laboratory was contacted and a test of the remaining seed showed the seed to be unfit for planting. The 3% of weak germination did not produce in the field and although a small percentage of the hard seed was found to be viable it was not strong enough to grow vigorous healthy seedlings.

New York State has provisions in its seed law to protect the buyer of tree seed. Tree seeds offered for sale within this state must be correctly labeled as follows:

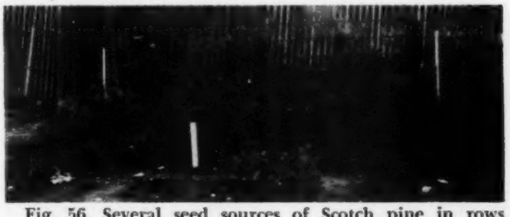

Fig. 56. Several seed sources of Scotch pine in rows showing variation in height growth and needle length as 2-2 transplants. Even the yellowish coloration is showing in the riga source at extreme right. The front center stake shows a Spanish strain 1-1½ ft. in height. The two fast growing long-needled strains at right by yardstick are North German and Polish strains 2½-3 ft. in height. Photo taken November 1.

(1) The kind of seed and the variety.
(2) The percentage by weight of pure seed.
(3) The percentage of germination.
(4) The year of collection of such seed.
(5) The specific locality (state and county in the United States or nearest equivalent political unit in the case of foreign countries) in which seed was collected.

Other states including Georgia, Michigan, Massachusetts and Pennsylvania have some provisions regarding the labeling of tree seed in their law. Some progressive, reliable tree seedsmen are making germination tests on all or part of their seed which is being offered for sale. It is the buyer's responsibility to know the quality of the seed he purchases from the dealer. Request the dealer to furnish you with a germination percentage on each lot of seed and then have it tested at a seed laboratory for your own protection. By buying only high quality seed and knowing the actual germination of the seed, you can regulate the seeding rate so as to secure optimum seedbed density for maximum growth of strong, healthy seedlings.

SEED SOURCE AND EXOTIC TREE STUDIES

The writer has conducted research studies in an experimental personal nursery for over 15 years on many different seed sources of Scotch pine, Austrian pine, mugo pine, Douglas fir, Colorado blue spruce, Norway spruce, yews and other species. Close, observations on growth habit, rate of growth, needle length, winter coloration, winter hardiness and other characteristics have been made and recorded. Many of these special sources have been sold to Christmas tree growers and nurserymen for future study and observation. Special attention has been given to Scotch pine and Douglas fir the past 5 years for the Christmas tree growers in New York and Pennsylvania. At present the writer has tested over 40 known sources from nearly all countries in Europe from Sweden to Spain and from England to Turkey. Figure 56 shows several seed sources of Scotch pine as 2-2 transplants taken November 1. Height growth varied from 1-3 feet; needle length varied widely; winter coloration was yellow to blue-green, and type of growth varied considerably from one source to another. All sources tested are not shown in photo and several other series have been tested other years.

Douglas fir has extremes in color, height growth and winter hardiness depending on strain and locality collected. Under test this year is a series of 8 different glauca sources and 8 different green or grey sources.

Many exotic firs, pines and spruces from the West coast, Europe and Japan are being grown for study and distribution. Two of the spruces,

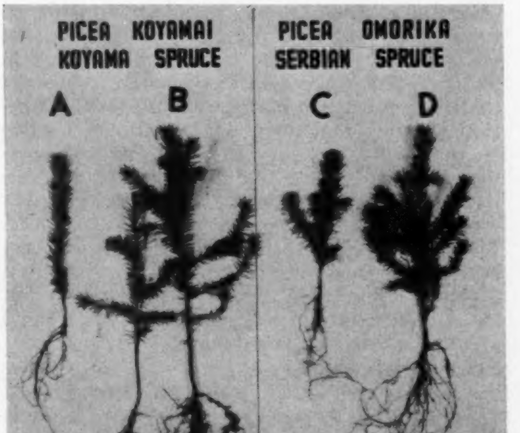

Fig. 57. Two year seedlings of *Picea koyamai*, A; Two 2-1 transplants under B; *Picea omorika* two year seedlings, C; and 2-1 transplant under D.

namely, Koyama spruce and Serbian spruce grown at the present time are shown in Figure 57, both as 2 year seedlings and 3 year transplants. Both have proved hardy at Geneva, N. Y. to date. One of the most interesting exotics to date is the Balkan pine (*Pinus leucodermis*). The writer is planning on publishing separately on this pine in the near future. It is short-needled, slow growing, dark green in color and native to the high mountains in Yugoslavia and Greece. It shows characteristics to be an excellent ornamental and to be a possibility for Christmas tree production if one desires a slow growing species.

This tree seed study in the nursery of various seed sources from many species and exotic evergreens has been both interesting, educational and profitable for the writer during the last several years. We think that many Christmas tree growers, foresters, and nurserymen have benefited from these findings because of the remarks received from many sources. We only hope that in the next few years more of these findings can be published so as to be of more value to everyone in the horticultural field.

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Associates' Corner

THE ARBORETUM AND THE ARTS

The Christmas season is upon us with its festoons of mistletoe and holly. Naturally, the evergreens at the Arboretum come to mind. But, although an Arboretum is primarily interested in living plants, it performs many other functions. Strange and surprising are the calls made on the Staff. They may be highly trained botanists, horticulturists, and bug experts, but believe it or not, they are expected to be artists too.

For instance, the head of a large jewelry firm wanted to create some costume jewelry based on dogwood designs. He appealed to the Arboretum for authenticity and was supplied with colored pictures, sketches, pressed and live specimens and library books.

Members of another firm were working hard on designs of Elm leaves and asked if their sketches were correct only to find they were specializing on a foreign elm when they particularly wanted to represent an American one. Disappointed, they suggested they would appreciate the right data and "please make it artistic." They were accommodated and expressed approval of the artistic element.

The same thing happened in another case with Mistletoe. Incidentally, European Mistletoe is very different from our indigenous eastern variety and the Arboretum prevented what might have proved an embarassing error.

An editor of a large publishing house telephoned to say that one of their artists was trying vainly to obtain an illustration of the flower of a Fig, under the impression that it would be spectacular and showy. It so happens that the flowers of the Fig are almost microscopic and hundreds of tiny blooms are borne inside the flask-shaped structure that later develops into the fruit and never even see the light of day. When this peculiarity was explained to him, he said "in that case our artist had better use a fig leaf."

Speaking of illustrators, many publishing houses send their artists to the Arboretum to sketch. They generally come on week-ends and are furnished with marked maps of the grounds so that they can find the desired material.

Nurseries also make use of the two thousand colored slides from the slide library for illustrating their catalogues and art schools borrow them

for lectures.

If you should want to pass a snowy evening by your own fireside, these slides may be borrowed by members. Students working on designs from Nature also avail themselves of this feature of the Arboretum's facilities.

These activities are by no means confined to local talent. An artist in Los Angeles was doing a book on American shrubs and needed species which cannot be found in the West to complete his records. His request was filled in 48 hours. That is how alert our Staff is.

The Director of an Arboretum in Spokane, Washington was featuring a two weeks exhibit of Ginkgo trees as living fossils, but could not obtain any fruiting material there. Specimens were promptly shipped by airmail. A friendly gesture between Arboretums 3000 miles apart, which makes me feel better about the awful smell we endure each Fall. These are just a few of the demands made upon our ever-willing and gifted Staff besides their own plenteous duties. Perhaps their close association with the beauties and marvels of Nature give them a more intense appreciation of all Art. At any rate, they respond one hundred percent.

When you get that lovely costume jewelry for Christmas or enjoy the pictures in that gift book may it bring up happy associations with our beautiful Arboretum. Christmas Greetings!

Marion W. Rivinus

Arboretum Activities

(Continued from Page 54)

exhibition to be held at Rotterdam from March 25 to September 25, 1960. For this show, which will be known as Floriade, it was decided that the botanical gardens and arboretums of this country should prepare an exhibit of their work. To Dr. Clarence E. Godshalk, Director of the Morton Arboretum at Lisle, Illinois, was assigned the task of assembling and preparing for shipment the exhibit materials submitted by the various institutions throughout the country.

In accordance with the directives adopted at Rochester, we have submitted the following materials for display at Rotterdam:

Kodachrome transparencies (suitable for enlargement) of the Arboretum.

Glossy prints of the Arboretum, showing several characteristic scenes.

A set of the Arboretum's publications, including the last five volumes of this Bulletin.

Data of an edaphic and climatological nature, e.g., geological formations and soil types within the Arboretum, extremes of temperature, length of growing season, average rainfall, etc.

It is hoped that, when finally assembled for exhibit at Rotterdam, these items, along with similar ones from other institutions, will present a comprehensive picture of the character and activities of American botanical gardens and arboretums.

Conifer Nursery

Many years ago a nursery for the propagation of conifers was established in a low-lying area below the greenhouses. For a variety of reasons most of these plants were allowed to develop beyond the stage where they could be readily lifted and moved. The result has been a veritable jungle of overgrown spruces, firs, arbor-vitaes, hemlocks and Japanese cypresses. In all but a few cases these conifers were so badly crowded and distorted that they were unfit for transplanting, even had they not been too overgrown for us to move.

This situation obviously called for drastic action and this autumn we have tackled it in earnest. A few fine, large specimens were given to Longwood Gardens, which possesses the equipment to lift and transport them. A few others were moved to new locations in the Arboretum. Most of what remained were then "rogued out" by a bulldozer and destroyed.

The result is an attractive grouping of a few carefully selected conifers and boxwoods, each with adequate space for development into well formed specimens. Into this area it is our intention to move our Medicinal Garden, utilizing the evergreens as background subjects against which our growing collection of the world's important drug plants can be effectively displayed.

J. M. F., Jr.

Library Accessions

Among the items which have been added to the Library during 1959 are the following:

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* Gift of the Author
** Gift of Mr. Joseph K. Skilling
*** Gift of Mrs. E. R. Kolupaev
**** Gift of Mr. Wharton Sinkler

Evaluation of a Small Apparatus for Heat Treating Soil

PATRICIA ALLISON

Did you ever think of a plant propagator as a practicing plant pathologist? Probably not. Neither have the plant propagators. But when they increase plants by cuttings, that is exactly what propagators must be, for their very starting material is at death's door. The condition of the cutting is not unlike that of the branch that has been girdled by borers or the tree that has been seriously wounded by a lawn mower or a shrub whose roots have been rotted away by fungi. These little would-be trees or shrubs in the propagator's hands have suffered complete amputation of their root systems, without which they would surely die unless given prompt help. The propagator-pathologist provides this "therapy" in three ways. First, the water-supplying characteristic of root systems is supplanted by other means. Water can be supplied through the foliage by syringing or mist systems, and the need for large amounts of new water is curtailed by keeping the moisture content of both air and medium high, thus preventing evaporative losses from the foliage. Second, the propagator-pathologist arranges for the early formation of an entirely new root system by keeping the stub moist, and even by furnishing it with chemicals that act like the hormones occurring naturally in the plants. Third, the propagator-pathologist protects the amputation wound and new roots from fungi, bacteria, insects, mites, and nematodes. This protection must be given not only to the cutting in the bench, but also to the young "recovered" plant after removal to soil in pots. The best method, as always, is to use a pest-free medium and keep it pest-free.

OBTAINING A PEST-FREE MEDIUM

Obtaining a pest-free rooting medium is not particularly difficult because mineral nutrition during that phase of healing is not nearly so limiting as water deficiency. Thus soil and compost can be omitted. Obtaining good, rich potting medium devoid of pests, however, is difficult indeed, and one must usually try to reduce the pest populations in an otherwise satisfactory soil rather than hope to find ingredients that are absolutely clean.

Both chemicals and heat are in common use. Chemicals have the disadvantage of expense, limited action against a variety of pests, toxicity to various plants, and toxicity to various propagators. The advantages of heat treatment heavily outweigh those of chemical treatment, but there are definite disadvantages as well. Too much "dry heat" can incinerate organic matter in the soil, and yet soil not far from the heat source remains too cool. Too much "wet heat," such as supplied by steam under pressure, can cause harmful changes in soil structure and mineral content. Too little heat of either type can fail to do the job, resulting in pockets of infested soil from which pathogens can grow into the clean soil. The problem, then is an engineering one, and the goal has usually been to heat all the soil particles to approximately 180°F and maintain the temperature for at least 30 minutes. The trick is in uniform heating.

When dry heat is used, the disadvantage of incineration and poor heat transfer can be lessened only by special equipment in which the soil moves past the source of heat.

Steam is the more efficient soil heater. Not only are microorganisms easily killed by it, but it penetrates soil well and has an enormous heating capacity. Furthermore, when flowing steam, rather than steam under pressure, is used, the danger of overheating is reduced. The maximum temperature the soil can reach is 212°F. If the equipment is properly designed, either bulk or moving soil can be treated with steam, although the former is preferred.

Several types of very efficient soil "sterilizers" have been developed for the nursery trade. These require a rather high capital outlay, and most are of extremely large capacity. Among the smaller units on the market are poor designs that merely represent waste of money and danger to personnel.

Should an institution like the Arboretum, then, simply plan to lose a portion of the cuttings taken and take more to make up for losses? Considering the premium on bench space and the rarity of some of the plant material propagated, let alone the danger of infesting otherwise healthy material, the answer is obviously, "No."

As a part of the current program of improving the green house facilities, begun in 1957 with the reroofing of the Fernery, a search for a relatively efficient, medium-capacity apparatus began. A Dillon Soil Pasteurizer was selected for trial and has been purchased.

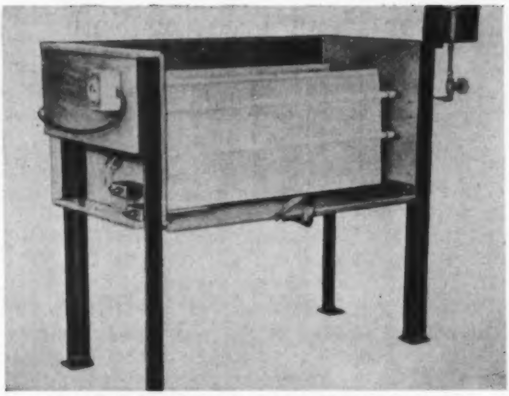

Fig. 58. Dillon Soil Pasteurizer. Front panel and controls cover removed.

Equipment Description

This instrument, with a capacity of one-fourth a cubic yard (approximately 400 four-inch pots), consists of a marine plywood box supported on steel legs. The lid is removed for loading, and the bottom opens for unloading. Within the box are two vertical heating plates that have steam openings along the mid-line. These plates are visible in the cut-away view in Figure 58. A small water tank is another important part of the apparatus.

The unique heating plates are the most important component of the instrument. They are electrically heated, but are under thermostatic control. This control mechanism does not simply turn the heaters on and off, but also activates a solenoid valve in the water line that allows water to flow into the heaters. The periodic addition of water to the hot plates reduces the critical disadvantages of equipment with conventional dry heating elements buried in a stationary mass of soil, namely the overheating (400-500°F) of soil next to the plates, the drying out of that soil, and hence the reduction in heat distribution from the plates. The entire operation in the Dillon Pasteurizer is timed, and the final power cut-off occurs upon a signal from a thermostat located at the coldest part of the bin.

Results of Trials

It was known that the potting soil was contaminated with fungi that kill seeds and seedlings, thus the first trials involved simply the comparison of the number of surviving healthy seedlings in soil that had been heat-treated with the number surviving in soil from the same batch that had not been treated. The plants were cucumber and garden peas. Fifty seeds of each were planted in each of three trials. Final data were taken three weeks after each planting.

On the average, 58 per cent of the peas planted survived in heated soil, but only 8 per cent survived in the unheated soil. Cucumbers were more resistant to the fungi. Eighty-five per cent survived in the pasteurized soil; 69 per cent, in the untreated soil.

Because counts and observations were made weekly, there was a fine opportunity to evaluate another of the advantages of using heat-treated soil—weed control. Each week all weed seedlings were removed and counted. From the 45 pots of treated soil involved in the three trials, a total of 17 weeds were removed. Three hundred fifty-four were removed from the non-pasteurized soil! Furthermore, the amount of algal growth on the soil surface was consistently less in the treated soil.

Another evaluation assessed the fungicidal effect of the treatment directly. A plant-pathogenic fungus, *Sclerotium Rolfsii* (the "mustard seed" fungus), was cultured in the laboratory. This fungus forms small, hard, brown bodies (sclerotia) that can survive for extended periods in soil. Both young and old sclerotia from cultures were used in the trials. These were wrapped in packets of 10 each in cloth and buried in various locations in the soil contained in the apparatus. After the heating cycle the packets were recovered. Sclerotia that had not been buried were placed on fresh culture medium; then the packets recovered from the soil were opened and their contents similarly planted. All ten of the twelve-week-old sclerotia that had not undergone heat treatment formed white, fluffy colonies. The same was true for the two-week-old sclerotia that had not been buried. But of the 80 sclerotia recovered from the soil in the pasteurizer not one survived. Two of the culture plates

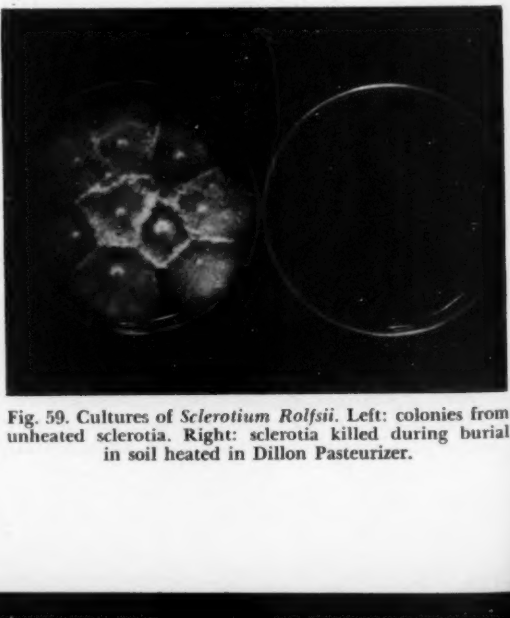

Fig. 59. Cultures of *Sclerotium Rolfsii*. Left: colonies from unheated sclerotia. Right: sclerotia killed during burial in soil heated in Dillon Pasteurizer.

are pictured in Figure 59, one with fungus colonies, the other without.

We are satisfied that the equipment will be very helpful in the greenhouses, not only in improving the propagation regime itself but also in reducing the weed control labor. Meantime, researchers in England and California are investigating the advantages of mixing air with flowing steam. When the mixture is carefully controlled, soil can be heated both rapidly and uniformly to temperatures below 212°F. Early experimentation has revealed that adequate control of certain fungus pathogens can be obtained at temperatures much lower than 180° F. In time, equipment plans should be available that incorporate more of the fruits of this research.

Book Review

THE GARDEN FLOWERS OF CHINA. By Hui-Lin Li. Ronald Press Company, New York, $6.50. 1959.

Many years ago E. H. Wilson, the indefatigable explorer and plant hunter, labeled China the "Mother of Gardens." That this epithet was well deserved is made abundantly clear in the present volume.

In a work replete with scholarship and sensitive perception, Dr. Li traces the origins of the most important and best loved Chinese plants which for centuries have adorned the gardens of the Orient and in more recent times have found an honored place in Western horticulture.

The author admits that the beauty of Chinese flowers is increasingly appreciated in the West, but goes on to point out that perhaps we fail to comprehend their distinctive symbolism. According to him, the favorite flowers of China are the peony, apricot, Cymbidium orchid, chrysanthemum, and lotus. These, and many other flowers are valued not alone for their intrinsic beauty, but because they symbolize various aspects of character and refinements of culture.

Following a brief review of Chinese horticultural literature, Dr. Li devotes separate chapters to the tree peony, the herbaceous peony, the chrysanthemum, the Japanese apricot (which is actually a native of China), the peach blossom, the sacred lotus and orchids. In all of these accounts the author embodies a wealth of historical and botanical information and emphasizes the symbolic significance of the plants treated.

Subsequent sections deal with such familiar and favorite forms as camellias, roses, lilies and day lilies, crab apples, magnolias, cherries, azaleas, lilacs, wisterias and many more.

In a chapter on exotic flowers the author traces the introduction into China from the West of such plants as pomegrante, oleander and crocus.

Finally he pays tribute to the many collectors from Armand David (the discoverer of the Dove Tree) down through Wilson, Purdom and Meyers. These are the men who, by their pioneering spirit and insatiable curiosity, have so vastly enriched the gardens of Europe and North America.

Among the features which enhance the value of this book are a table of Chinese dynasties, a bibliography of older Chinese works, and an index to Chinese plant names.

The volume is adorned with fifty line drawings (most of them copies of Chinese originals) and a number of carefully chosen and beautifully reproduced plates.

One closes the cover of this work with an increased awareness of the inestimable contribution which the floral treasures of China have made to the gardens of the West.

J. M. F., JR.

Index To Volume X

Nos. 1-4, inclusive (1959)

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